It may be further noticed that while the movements described are each different and peculiar to a single genus of plants, they are unlike those of the well-known balsam, and those of the witch-hazel as given by Mr. Meehan a few years since.

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INSTINCT AND REASON.

BY F. C. CLARK, M.D.

IF the great array of startling facts, presented in the works of Mr. Darwin, be not wholly convincing, they at least clearly demonstrate a somewhat closer connection of man with lower organizations than has hitherto been acknowledged. Since the invention of the microscope and its application to the natural sciences, the study of natural phenomena has opened a field of inquiry never before dreamed of by the most imaginative theorist. Myriads of infinitesimal forms of life, which formerly escaped detection, have thus been revealed, and though many a one lacks that complexity of organization which usually attracts our notice, yet even in their simplicity they present a problem as intricate and perplexing as the most highly organized being. These minute organisms often seem but mere centers of life (points of attraction), around which cluster other existences still more minute and but just perceptible to the highest powers of the microscope. Organization appears, many times, hardly more than nominal. Even to-day their nature defies solution, so as to render it impossible to assign them any satisfactory place in the scale of being; and after the new discoveries daily added, the naturalist is at a loss to find the dividing line between the various forms of life expressed by the old names of "animal" and "vegetable."

The division of the living world into the "vegetable" and "animal" is at best but arbitrary. It is not enough to take well characterized types of each division and compare them with each other. Such differences would be self evident. But, instead, it is needful to give such a definition of each division as will cover every variety, however diverse, which is included in that division to which the definition has been given. Thus, much confusion in classification is avoided; though, unfortunately for us, the problem remains unsolved; for the new facts daily brought to light render necessary continual changes in classification, and

broader definitions. In the present state of natural science the best classifications cannot be otherwise than approximate and unsettled. But the link between unorganized and organized matter has thus far defied discovery. Whether the different expressions of existence are due to that inherent change exhibited by all matter—that change in which all natural phenomena consists, resulting in a spontaneous generation, the necessary elements or factors being present; or whether to a special creation to satisfy each individual case, as a species; these are questions still under dispute, whose explanations have their different disciples.

Passing by that which makes up the organization of all living beings—the mineral—it is designed in the following pages to discuss the manner in which the different vital forms express their existence under their different phenomena, dependent of course upon their individual organizations. Hence organization determines the character of the individual as well as of a species or family. But it should be here stated that it is not intended to discuss the province of a species. This is for the specialist.

Again, we are to observe how each organized being supplies its wants and the means or organs for supplying them. In every form of life, however high or however low in the scale of being, there must necessarily be some way in which each form maintains its existence. It is not to be expected that all vital beings, irrespective of their organization, demand the same mode of supply, but some means of supply. Each after its own kind must so dispose of the elements of nutrition about itself as best suits its organization. Each one, therefore, will take from the alimentary substances it receives only that best suited for it, or is refused, or avoided by other higher or lower forms. In this way that constant change of elements is effected by which all life is supported; by which the structure of one is fitted for a higher form of life; and the detritus of a higher prepared for a simpler and more lowly being. Thus does the vegetable supply the animal with food, and in turn the animal adds to the growth and vigor of the plant. The luscious fruits of the garden, which form a part of the delights of life, contain the same elementary principles found in man, but there taken at second hand. The vegetable being a builder up of tissue can exist where the animal would become extinct, for it is the tendency of all animals to destroy combinations and to form compound products.

Now, for these various forms of life to effect these important and complicated results, there must needs be some power behind all capable of directing the phenomena manifested in each individual. The selection of the required food, the choice of a habitat, and the end of all—the ultimate propagation of its kind—are by no means mechanical phenomena.

The general opinion has hitherto been, that man was guided by intelligence or reason, and the lower animals, without exception, by instinct, differing most essentially from reason in that it was innate. Gradually, however, many of the actions of the lower animals, as well as some of man which were regarded as instinctive, were acknowledged to be intelligent. These actions were supposed to be the same in kind, but different in degree. A step was thus made in advance; and what could not be longer denied forced itself upon the attention of all.

It is a matter of peculiar difficulty to draw a line of distinction between instinct and reason. The best thinkers, among whom may be cited Herbert Spencer, consider that no *hiatus* exists between the two, but that the one passes into the other by insensible degrees.

Simple reflex action, sometimes called "reflex action of the spinal cord," is wholly unconscious action. It is the action of muscles seen in decapitated frogs, and in acephalous children (monsters) who, in their short life, perform simple acts as readily as babes with brain intact. Herbert Spencer supposes the simplest acts to be unconscious, performed by the animal automatically, in its endeavor to get rid of offending matters. And this acquired power is inherited and becomes then instinct, or complex reflex action of another sort.[1] Instinct is the inheritance of accumulated experience; is also a lower grade of intelligence, into the highest of which it gradually develops. The dog after having been taught the trick of "begging" will transmit that faculty to its offspring, which will be used as occasion requires.[2] Mr. Lewes and Mr. Spencer appear to agree in regarding instinct as being lower than reason. Acts which were once voluntary and intelligent may become involuntary and habitual, then instinctive. And as acts became more complex they become less frequent, and more subject to the control of the will. Hence instinct is "lapsed intelligence," so to speak.

[1] Psychology, Vol. i, p. 432 and foll.

[2] Problems of Life and Mind, Vol. i, p. 208 and foll.

Some French writers and others do not separate impulse from instinct. This, Mr. Lewes opposes, since in instinct we see only one course of action often followed, when other sources as good may be at hand. This course of action is the result of accumulated experience inherited from the parents. But at the same time a change in the course is sometimes manifested, which would imply a slight degree of intelligence. From this it follows that reason differs from instinct but in degree rather than in kind, as instinct does from impulse. But as impulse denotes the suddenness of an act, and as an instinctive act follows so swiftly after the impulse or desire has once been formed, it becomes very difficult to separate the two. Roughly speaking then, instinct may be described as the *directing force* in simple habitual actions; while reason, in every case implies conscious memory, and may be viewed as the *guiding and directing force in every act which is not habitual. It is the putting in order of the proper apparatus to work in the best direction; or the proper selection of the best mode of acquiring wants.* In instinct then we have no consciousness of action, but reflex acts performed automatically. Hence the common error of applying intelligence only to the acts of man cannot be too much deprecated. Instinctive acts are as common among men as among the lower animals; and even in some species of plants, we note phenomena so wonderful as to cause some hesitation in classing them entirely among instinctive acts.

The theory of evolution aids us greatly in explaining many of the phenomena observed in the lower forms of life, perfectly inexplicable by any other mode of inquiry. From the simple and hardly exertive act of the monad to the complex and manifold actions of man, we cannot fail to perceive a constant progressive development, undeniable and indisputable. Each separate principle, if separate and distinct it be, overlaps another, there being no chasm, no break to evince the beginning of one and the ending of the other. The simple reflex act becomes compound; phenomena cease to be involuntary, and become conscious and intelligent.[1]

First Forms of Life.—In regard to those transitional forms of life whose place in nature has not yet been determined, which multiply like the individual cells which make up animal and vegetable structures—by fissuration—little can be said respecting

[1] Principles of Psychology, Vol. i, p. 432 and foll.

either their instinct or reason. But that one or both these principles must be present, can be best seen from their analogy to higher forms.[1] But if, as Herbert Spencer teaches, instinct is but compound reflex action, and if in these lowly beings we observe simple reflex action to predominate over compound, it is but a step to invest even these transitional forms with some degree of instinct. And again following the same author, we cannot fail to see, from analogy at least, some degree of reason, however slight.

It is seemingly so immaterial to this class of beings as to their place of abode, and so easily and rapidly do they reproduce their kind, that it is not surprising that the theory of spontaneous generation should have received so much attention and gained so many partisans. Still, in what light soever they are viewed, they must be allowed the requisite elements of growth and function; for without these they must as truly perish as the higher forms of life when they, too, are deprived of proper function and nutrition.

Whether regarded as animal or as vegetable, these lowly forms must be conceded some skill, however slight, for obtaining wants and for protection against enemies. Few, if any, of the higher forms of life are unprovided in this respect. Thorns render plants less liable to injury. The cuttle-fish stains the water in the track of its enemies of an inky blackness, and thus escapes. The spider simulates death; and so does many a crustacean. The polyp can be severed into hundreds of fragments, but it revenges itself by reproducing as many new individuals; and the mollusc is protected from foes by a hard closed shell.

Our knowledge of the lowest of the protozoans is but scanty, yet they all have means for engaging successfully in the struggle for existence. Each protozoan, or other, must put forth efforts proportioned to its development, to be met and overcome by still higher development. Something is displayed in the contest of offence and defence which seems like intelligence, but more akin to instinct. Their actions observed here are so nearly related to reflex action alone, that the problem of separating instinct from pure reason is at present utterly impossible. But yet where observation fails analogy will perhaps succeed.

Now if, for example, we touch with the point of a fine needle

[1] Vid. Pop. Sci. Monthly, Dec. 1873, p. 180.

one of those beautiful bell animalcules, named Vorticella, it instantly darts backward as though attached to a tense elastic thread. If we observe it more carefully we perceive the stem of the bell flower to be gathered into several spirals like a helix. After a while the animalcule recovers from its fear and extends itself, spiral after spiral being shaken out. If the vessel in which they are contained be jarred even, they dart quickly backward as if touched. After a short time they get accustomed to jars and the like, and a considerable shock is required to cause them to withdraw into the depths of the vessel. Now here at least, some impression, strong enough to affect them greatly, is made upon these little bell-flower animalcules. If instinct be advanced to explain this phenomenon, then the onus of proof, as to where instinct ends and reason begins, belongs to the one who advances that idea; if reason, however small, then we must allow the consciousness of action to obtain in all the processes of nature.

Every form of life, then, whether animal or vegetable, does but furnish different modes of expressing life. What is lacking in one is made good by approximation, so far as it is consistent with the needs and demands of that organism. The plant has no brain, no blood circulation; but the sap of the plant is pumped up by the rootlets throughout every part; and the circulation here is as perfectly established as in the animal, though in a different manner. For their purposes in life, then, these transitional beings need no complexity of nervous system, roots and sap. They would have no call for them in so simple an organization as they possess.

Plant Life.—A plant, as we understand it, is a cellular organism, consisting of a part below ground called the roots, and a part above denominated stem, branches and leaves. Parasitic plants have properly no roots, but, as their name implies, subsist upon higher vegetable forms. Air plants, fungi and lichens also belong to our category of plants, although differing so widely from our type.

Plants, being for the most part limited in motion, shoot out roots in all directions beneath the ground in search of elements of nutrition, rear a stem aloft, push out branches and put forth leaves to catch the sunbeams, by means of which they decompose the atmosphere to obtain the proper requisites for the life, respiration, growth and vigor of that form of life. The plant never

fails to direct its stem, branches and leaves towards the sun; and in our typal plant, roots never fail to be thrust downward into the earth, in what form soever it may be placed in the ground. Leaves often change to roots, and roots in favorable circumstances become leaves. The greater the spread of foliage the more vigorous and, consequently, the healthier will be the condition of the plant. At this point it may be well to note a universal law or principle: the more sunshine and air (of course at some time reaching a limit) the more abundant the foliage, and the denser the foliage the stronger and more flourishing the plant. This may be proved by comparing out-door plants with badly managed in-door and hot-house vegetation. Plenty of sunshine and air soon show a marked change for the better.

Illustrating the subject by means of our type, we find the organs of a plant to be roots, leaves and the modifications of the leaves for reproductive purposes. The stem, or trunk, is but a canal, altering in size to suit the varying conditions of the plant, and is used for purposes of alimentation and the circulation of vegetable products between the roots and the leaves. The growth of the stem depends upon the same law which governs the growth of the roots and the branches upon which the leaves are supported. In a word, the stem seems to act as a support for the leaves. Growth itself depends upon the proper assimilation of the elements of nutrition derived from the chemical changes occurring in the roots and leaves, and to some extent in the stem.

Marine and fresh water algæ, if deprived of roots, have in their remaining organs all the functions necessary for their peculiar mode of existence.

The structure of a plant is cellular, showing its origin to be from the segmentation and accumulation of cells, one upon the other. The microscope shows how beautiful is the plant tissue, and how different in different varieties, but in every one this distinct cellular formation is apparent.

The plant is also possessed of the means for assisting its growth, as runners, creepers, tendrils and the like. For reproductive purposes it has nettles, thorns, elastic fibres, as in the seed vessels of the squirting cucumber (*Momordica elaterium*); but above all in its essential organs of reproduction—its flowers containing the stamens and pollen, ovary and pistil. The first

class of propagating agents are secondary or non-essential, the latter the essential organs. The former passive agents, the latter active.

Thorns, briers, nettles, etc., are also passive elements of defence. For offence many plants have a singular apparatus, especially that curious class of plants termed insectivorous, or carnivorous, hereafter to be discussed.

But the plant demands food. This it obtains in a peculiar way. Its anatomy and physiology are adapted to that peculiar way. It does nothing contrary to nature with impunity. Mode of growth in all plants tend to the same end. Hence the lowest as well as the highest can do no more than supply wants; seek a situation best suited to its growth and development; remove or avoid obstacles interfering with growth, and reproduce its kind in due time. For this purpose certain organs are exercised, and this constitutes the functions of a plant.

In plants, as well as in animals, we everywhere perceive the operation of the law which secures to them what naturalists term "the survival of the fittest." The weaker must succumb to the stronger, and disappears, is annihilated, when the struggle for existence becomes too great for that form of plant life.

Plants which need much air (or elements of air) and light, and moisture, are found in situations most favorable for obtaining them; if deprived of them the result is obvious.

In the case of most terrestrial plants, a suitable depth and character of soil are required. If the soil be too poor in the elements of nutrition required by a peculiar kind of plant, or in excess, or the soil too dry or too light, the different elements must be duly supplied or apportioned, and sufficient moisture furnished by irrigation lest the heat of the sun destroys the roots of the plant. The same principles are observed in respect to all the classes of the flora spread over the earth. Warmth implies light or sunshine, and where it is wanting none but the lowest orders, like the lichens and algæ, survive. The different climates also possess their own vegetation, and even in different regions of the same zone we find plants totally distinct from each other. Hence circumstances, as well as conditions, must find a place among the demands of a plant.

For the removal of obstacles the plant has two courses, to disintegrate the object opposed to its progress, absorbing it if it be

a suitable nutritive element, as are all animal and vegetable substances and some minerals; or pass around it; or still again, as in extreme cases, to bury it up in its own substance, as are stones, bayonets, nails and the like.

For its protection, defence and reproduction the plant has at hand sufficient means. Some of the many devices for these purposes have already been noticed. The manner of plant reproduction is familiar to all; the object being in all cases the contact between pollen and ovary or seed vessel. In this way the propagation of most plants is effected. In regard to the flowerless or cryptogamous flora, spores, it will be found, take the place of seeds proper. Yet for all that, the principle of reproduction remains the same in both divisions.

Such, then, are the organs, functions and factors exercised in the life of a plant. It now remains for us to consider how these are put into action according to the means at hand, pursuing as the plant does, many times, a most reasonable course, and acting in a manner so peculiar as to excite our wonder and admiration. We must first remember, however, that we have to do with a form of life whose phenomena have been but little studied, for it was not till late in the period of the *Renaissance* that botany became a a separate science, and that plants had a natural classication of their own.[1]

Plants are susceptible of improvement, which is well shown by cultivation. Thus flowers take upon themselves a great variety of forms and colors, and sometimes to so great an extent as almost to deserve to be classed as new and distinct species. But yet there is sufficient likeness between them, some characteristics traceable to the original stock; or some peculiarities due to inheritance; some similitude to the parent to make them belong to the same species. Darwin considers all the different species, or varieties of pansy to be derived from one parent, as may be said in reference to the pigeon and the dog kind.

Trees often adapt themselves, in a remarkable degree, to the surrounding circumstances. Thus the feral oak, growing as it does in the midst of other trees, which oftentimes are densely crowded together, sends out branches at a more acute angle than does the meadow or cultivated oak. Much difficulty is experienced in cultivating the feral variety, so as to give it the grace and

[1] First Nat. Sys. Bernard de Jussieu, 1759; Figuier Vegetable World.

beauty of the meadow oak. Other trees, like the walnut and chestnut, present the same peculiarities.

Plants appear to possess sensibility, and often to a remarkable extent. If the well-known sensitive plant be touched never so lightly, if but a breath blow upon it, its flowers and leaves close; and some time elapses ere it dares to expand them again, as if it knew the danger threatening it. If only a sister leaf be touched the rest close as if out of sympathy.[1]

Drugs exert their peculiar influence upon plants as upon the higher animals. Spirits of ammonia, if applied too strong, will be fatal; opium puts the plant as effectually to sleep as it does man; prussic acid is also destructive; electricity exerts here its peculiar and wonderful effect.[2]

In plants, as in animals, we sometimes observe what is termed "suspended animation." This phenomenon is well instanced in the "resurrection plant," generally known as the Rose of Jericho. It is found in Arabia, near the shores of the sea, to all appearances a mass of dry, dead vegetable fibre. But when sufficient moisture is supplied, it revives, its leaves expand, it is clothed in new verdure, and as it blossoms unfold, the reanimated plant is clothed in all its former beauty. No wonder is it that the Rose of Jericho should be almost adored by the simple people among whom it is found.[3]

The Sleep of Plants.—When night approaches, flowers close their petals, and thus at rest, only wake when the sun once more ushers in the day. DeCandolle, as did Linnæus before him, made many experiments with plants in this particular. At night, plants were exposed to a bright light, and during the day were placed in a darkened room. After some irregularities, the change of conditions was finally adopted by the plants, and in the lighted room they would blossom, and close their petals and leaves in the darkened one.

Some plants, however, only flower at night. The beautiful Yuccas, a species of wild lily, only blossom when the moon is out. The night blooming cereus only blooms as its name indicates. Hence the time, as well as the season and the climate, etc., seem to be elements of importance in the flowering of plants. These conditions may be slightly varied, as seen above.

[1] Vid. "Wonders of Vegetable World." Scherl De Vere.

[2] Ibid.

[3] Ibid.

The Movements of Plants.—Slow motion is obvious in all plants, as in their growth, and in their tendrils, creepers, etc. But the most rapid and continuous motion probably possessed by plants, is exhibited in the *Desmodium gyrans*, of India. Each leaf of this plant consists of three parts, two external and small leaflets, and one central and large leaflet. The external leaflets move up and down in alternate jerks, at the rate of sixty a minute. The central one moves but little. This motion is continued during all the seasons of the year, and during the whole lifetime of the plant. Warmth and moisture, however, expedites the motion.[1]

The Offensive Weapons of Plants.—The first of these offensive plants is the familiar Venus's fly-trap (*Dionœa muscipula*) which sets its traps, and woe betide the unwary insect which ventures near the the hidden toils, allured by its attractive appearances. The springs are all set, the prison prepared and sure destruction awaits the victim.

The *Darlingtonia californica* belongs to the pitcher plant family. Its appearance has been likened to a cobra in the act of striking. The beautiful "red wattles" within the brim of its pitcher offer irresistible attractions to insects, especially to flies. These alight first upon the "wattles," then flying upward strike the pitcher, and owing to the peculiar twist of its walls fall to the bottom of the receptacle, where many another thoughtless fly has, too late, found its sepulchre.[2]

Dr. Erasmus Darwin,[3] grandfather of the celebrated naturalist of the same name, about a century ago, advanced many curious theories respecting the consciousness and volition of plants, in a work under the title of "The Loves of the Plants." This book at the time was much ridiculed. Plants seem to put on their most gorgeous dyes for the same purposes as the animals; and the idea of the "loves of the plants," though seemingly absurd, needs more investigation ere it be wholly discarded and ridiculed.

Plants not only actually eat and digest animal food, but also drop the insects they have destroyed, upon the ground, and thus fertilize the soil.

Dr. Hooker has described several kinds of plants which subsist upon animal food, and are hence termed carnivorous. The

[1] Wond. of Veg. S. de Vere.

[2] Loc. cit.

[3] For what follows, vid. Sci. American Dec. 22, 1874, and July 3, 1875.

present Mr. Darwin has investigated the same subject very carefully, and found that when a fly was caught by one of these plants, it would be dissolved in a gastric fluid exactly like that of the animal stomach. Pieces of beef and the like, when subjected to the same process, were acted upon in like manner. Hard mineral substances, like chalk, would, after a time, be rejected by the plant, though seized upon at first like the rest, shall we say as soon as it found out its mistake?[1]

In this country a lady has enlightened us greatly upon this subject by her interesting labors upon the bladder wort (*Utricularia neglecta*). Mrs. Treat has studied the habits of this plant very carefully, and learned that it allures animalcules by means of its bright flowers and leaves glistening with dew. The water bear and other microscopic forms of insect and vegetable life seem to be its food.[2]

Instinct and Reason.—On analyzing the various opinions formed at different times in the world's history, in regard to the reasoning power, or consciousness of action displayed by plants, we shall meet with extremists on both sides of the question. Passing over the mythological accounts of plant metamorphoses, so attractive to the refined Greek and Latin, we only advert to the mental faculties with which the ancients were pleased to endow many plants.

Many in more modern times have lavishly bestowed souls upon plants, as did Adanson, Bonnet, Hedwig and Edward Smith. Martius and Fechner, of Germany, defended these views, and were very liberal in their supply of souls to plants, even regarding them as sentient beings.

Another class, taking the opposite side of the question, among which may be reckoned Hüler, regarded plants as only susceptible to the material influences of the universe. So Descartes made all animals, so far as he could, mere automatons.

The views of naturalists of our own day are more consistent with nature and common sense; that all plants obey as infallible a law as do animals, and are subject to like influences as was observed above. Bichat in his great work on "Life and Death,"

[1] Huxley found in plants something comparable to a nervous system; Darwin something comparable to reflex action.

[2] New York Trib., Feb. 1, 1875; also Darwin's "Insect. Plants," Sir J. Lubbock's "Brit. Wild. Flowers."

admits that plants show a life as active, and a sensibility as great as do most animals.[1] Any disturbance of the conditions under which plants thrive are as fatal as the subversion of the relations upon which the lower animals and man himself depend for existence.

In the investigation of this part of our subject, we must remember that we cannot see exhibitions as great as in the more complex forms. Each plant, transitional or not, displays in the struggle for existence and the survival of its kind, a force, an influence almost as great and wonderful as is exhibited by mankind. And though standing above all this, as head and chief, man is too often forgetful of the relation he bears to the innocent weed that is in the pastures bred; too thoughtless, many times, of the vegetable on which he depends for his subsistence and being; too ignorant of the chain which leads from the lowest vegetable form, to the beauty and perfection of his manhood.—[*To be continued.*]

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THE DISCOVERY OF "TURTLE-BACK" CELTS IN THE DISTRICT OF COLUMBIA.

BY W. J. HOFFMAN, M.D.

ALTHOUGH the rude stone implements forming the subject of this paper were not found under such circumstances as to assign to them the age that some have suggested, yet the term "turtle-back" is retained for the purpose of distinguishing them from the ordinary modern rude forms, and to illustrate their relationship to some extent to the older and *typical* specimens described and figured by Dr. Abbott.[2] Before giving a description of the implements, the locality of their discovery will be necessary. The surface thus far examined, covers an area of less than two acres in extent, and is situated on the left or south bank of the eastern branch, in Uniontown, D. C., about an eighth of a mile above the bridge connecting that town with Washington city. From the branch southward, the surface gradually rises in elevation, and the region upon which the chief specimens were

[1] Loc. cit.

[2] Am. Nat., x, p. 331; Tenth Ann. Rep. Peabody Mus. Am. Archæol. and Ethnol. II, pt. 1, 1877. pp. 30–43, figs. 1–3; Eleventh Ann. Rep. Mus. Am. Archæol. and Ethnol. II. pt. 2, 1878, pp. 223-257, figs. 1–4.